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Injuries due to exercise and training are common, particularly in Army populations. Few studies have examined the relationship between race and such injuries. Eight-hundred and sixty-one male and female Army trainees were followed over their 8 week Basic training course. This program,with its standardized activities and similar risk exposures provides a unique study environment.
Demographic, body composition and physical fitness characteristics were measured on all volunteers. Fifty-two percent were white and 39% black. White trainees were significantly fatter and weaker than black trainees. White female trainees were significantly more likely to experience a time-loss injury than black female trainess (52% vs 32%, RR = 1.6, $p<.05$). White males had slightly higher rates than black male trainees, 19% and 14%, respectively (RR = 1.4, $p>.05$).
The differences in overall injury rates could not be explained by differences in body composition and physical fitness. For time-loss injuries, white female trainees had 3.7 times greater odds of injury than black female trainees, even after controlling for other factors ($p<.05$).
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Race and Injury Among Army Basic Trainees

Nicole Bell*
Paul Amoroso**
David Hemenway***
Tom Mangione*
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Injuries due to exercise and training are common, particularly in Army populations. Few studies have examined the relationship between race and such injuries.

Eight-hundred and sixty-one male and female Army trainees were followed over their 8 week Basic training course. This program, with its standardized activities and similar risk exposures provides a unique study environment.

Demographic, body composition and physical fitness characteristics were measured on all volunteers. Fifty-two percent were white and 39% black. White trainees were significantly fatter and weaker than black trainees. White female trainees were significantly more likely to experience a time-loss injury than black female trainees, (52% vs 32%, RR = 1.6, $p<.05$). White males had slightly higher rates than black male trainees, 19% and 14%, respectively (RR = 1.4, $p>.05$)

The differences in overall injury rates could not be explained by differences in body composition and physical fitness. For time-loss injuries, white female trainees had 3.7 times greater odds of injury than black female trainees, even after controlling for other factors ($p<.05$).

Possible explanations for the remaining risk difference include physiology, prior physical training, or differences in health care seeking or risk taking behaviors. Our results suggest that the latter two are less supportable explanations for the risk differential. More information is needed in order to clarify this issue.

Injury interventions and evaluations should be formulated with respect to study population gender and race distributions. Future studies of exercise and training injuries may need to control for the confounding influence of race.

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INTRODUCTION

Injuries are a leading cause of morbidity and mortality among young adults[1,2]. The problem is particularly troublesome for the military.[3-5] Injuries resulting from exercise and physical training activities, while rarely life-threatening, are quite common and lead to lost-work time, medical costs, and adverse long-term sequelae.[4-13]

Race has received relatively little attention as a risk factor in the civilian sports medicine literature even when other demographic factors, such as age and gender, are included in the analyses.[14,15] A recent study of black and white workers found blacks to be at lower risk of non-work injuries than whites.[16] While cause of injury was not specified, one might surmise that some of these injuries were the result of exercise, training and recreational activities.

Several military studies have identified race as a risk factor for training related stress fractures.[17-19] White female Army trainees experienced an 11.83 cumulative incidence of stress fractures compared to 1.39 for black female trainees.[17] These findings suggest that race may be an important risk factor and that studies which do not control for race may have confounded results.

The etiology of the apparent risk difference is not clear. Blacks in the United States tend, on average, to have greater muscle and bone mass and tend to be taller than their white counterparts, even after controlling for socio-economic variables.[20] These differences have been documented across all developmental stages: from the fetal period through old age. They do not erode over time or with change in socio-economic status.

Military studies have also documented greater bone and muscle mass among black soldiers, relative to white soldiers, and a lower percent of body fat among black male soldiers.[21-23] Such differences in body habitus may affect injury rates. For example, higher bone volume and larger bone circumference may protect against fractures and stress fractures.

Race, as a marker for culture, may be associated with different health behaviors.[24-26] Cultural, or normative differences associated with race might influence both the identification of an injury and the perceived need for health care.

Military training populations offer unique study opportunities in that many potential confounders are

controlled by the very regimented training environment. Physical training and exposure to risks, access to medical care, diets offered, and the living environment are highly controlled and standardized for all trainees.

This study examines the relative rates of injury among black and white racial groups during Army Basic Training and explores the extent to which body composition and physical fitness may explain any differences in risk of injury.

METHODS

Eight-hundred and sixty-one Army basic trainees were followed over their eight week Basic Combat Training (BCT) course (509 men and 352 women). Risk exposures were very similar as all trainees were required to complete the same set of physically rigorous training objectives.

The population of potential study volunteers included all women entering female training companies formed during one month, in the fall of 1988. Roughly one out of four male companies, formed during this month, was also selected. The study design and objectives were explained to all potential volunteers (1075). Ninety-three percent volunteered to participate in the study and signed volunteer consent forms. Anthropomorphic measures were not obtained

on 14% of these subjects precluding them from this analysis*. There were too few Hispanics, Asians and other racial groups (less than 10% of the population) for statistical comparison so only blacks and whites were included for analyses (n = 783).

Study volunteers were screened, through a survey, to determine demographic characteristics.[4,7] This information was verified by comparison to recruiting station records. Other volunteer characteristics and physical fitness were assessed prior to basic training and included height, weight, measurements for calculation of percent body fat, strength and flexibility.[7] Initial Army physical fitness test scores and end of training Army physical fitness test scores were also collected.

Investigators measured heights and weights of volunteers dressed in uniform pants, t-shirts and bare feet. Percent body fat was estimated by taking a series of circumference measurements at specific anatomic points in accordance with Army guidelines.[27,28] Flexibility was measured by a device which assesses the range of motion possible, in

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* The subjects eliminated due to missing data did not differ significantly from the subjects included in terms of their overall injury rates or their racial distribution.

a sitting position, when stretching over the toes.[5] Maximum isometric hand grip strength was used as a measure of muscle strength.[27]

Army physical fitness test scores included the maximum number of push ups and sit ups performed during two minute timed intervals, measured at both the beginning and end of the eight week training period. A timed one mile pre-basic training run, as well as a timed two mile end of training run, were also conducted to measure aerobic fitness.

Investigators reviewed all medical records from the Basic training period. Injury diagnoses, made by clinic physicians, blinded to their patient's study involvement, were transcribed from the medical records. Injury definitions for this analysis included any clinic visit ("sick call visit") resulting in an injury diagnosis--generally musculoskeletal or related joint and ligament insult. A serious injury was defined as an injury visit resulting in at least one day of lost training.

Mean values and standard deviations for demographic, body composition and physical fitness characteristics of the population were examined for each racial group, stratified by gender. T-tests were used to assess statistically

significant differences between racial groups. Injury incidence among black and white study participants were compared using chi-square tests of significance.

Continuous fitness variables were categorized into five, roughly equal sized, groups, or quintiles, where relationships to injury may be non-linear.[5,7,29,30] The highest performing group was used as the comparison (referent) for analyses. Multivariate models were constructed and analyzed in an incremental, hierarchical model building process, using logistic regression analyses.

RESULTS

More male recruits were white, while the majority of female recruits were black (Table 1 and Table 2). No significant differences in mean ages, heights, weights, or flexibility were identified. However, black trainees were stronger and leaner than other trainees of the same gender. Black female trainees did significantly more sit ups than their white counterparts. Black male trainees did significantly more push ups and could run faster than white male trainees.

TABLE 1. MEAN VALUES FOR POPULATION DEMOGRAPHIC, BODY COMPOSITION, AND PHYSICAL FITNESS CHARACTERISTICS FOR FEMALE TRAINEES -- BY RACE

	BLACK (n=168)	Standard Deviation	WHITE (n=151)	Standard Deviation
VARIABLE				
AGE(yrs)	20.1	(3.2)	20.7	(3.8)
HEIGHT(cm)	162.7	(6.8)	161.6	(5.9)
WEIGHT(kg)	57.5	(6.6)	58.0	(6.2)
BODYFAT(%)	25.6*	(3.9)	27.3*	(3.9)
FLEXIBLE(cm)	32.1	(5.7)	32.9	(6.3)
STRENGTH(kg)	70.7*	(13.7)	64.1*	(11.8)
SIT UPS(n)	33.7*	(13.7)	28.3*	(13.2)
PUSH UPS(n)	11.1	(8.1)	10.4	(6.6)
1 MI RUN(min)	10.1	(1.4)	10.2	(1.8)

* = Significant difference between black and white trainees ($p < .05$)

TABLE 2. MEAN VALUES FOR POPULATION DEMOGRAPHIC, BODY COMPOSITION, AND PHYSICAL FITNESS CHARACTERISTICS FOR MALE TRAINEES -- BY RACE

	BLACK (167)	Standard Deviation	WHITE (297)	Standard Deviation
VARIABLE				
AGE(yrs)	20.0	(3.1)	20.1	(3.3)
HEIGHT(cm)	175.9	(7.2)	175.3	(7.3)
WEIGHT(kg)	77.2	(12.3)	76.0	(12.4)
BODYFAT(%)	14.4*	(5.2)	17.2*	(5.5)
FLEXIBLE(cm)	34.6	(6.0)	34.9	(6.5)
STRENGTH(kg)	125.3*	(23.1)	113.5*	(18.3)
SIT UPS(n)	45.2	(11.0)	43.5	(11.7)
PUSH UPS(n)	34.2*	(13.0)	31.5*	(12.2)
1 MI RUN(min)	7.4*	(0.9)	7.6*	(0.9)

* = Significant difference between black and white trainees ($p < .05$)

White female trainees experienced the highest incidence of injury and black male trainees had the lowest (Table 3). White female trainees were at significantly greater risk of injury compared to black female trainees [RR =1.30, 95% C.I. = (1.07-1.57)]. While a higher percentage of white males had injuries compared to black males (28% vs 25%), the difference in risk was not significant at the .05 level.

TABLE 3. INJURY INCIDENCE BY RACE AND SEX

RACE	INCIDENCE	RELATIVE RISK	95% C.I.	(p)
MEN				
BLACK (n=167)	25%	----	---------	---
WHITE (n=297)	28%	1.12	(0.81-1.55)	.474
WOMEN				
BLACK (n=146)	51%	----	---------	---
WHITE (n=134)	66%	1.30	(1.07-1.57)	.007

The race differential was even more pronounced for time-loss injuries (Table 4). White female trainees were more likely to experience a time-loss injury than black female trainees [RR = 1.61, 95% C.I. = (1.23-2.10)] (Table 5). White men also appeared to be at greater risk than black men (19% vs 13%), but the associations were not statistically significant at the .05 level.

TABLE 4. TIME-LOSS INJURY INCIDENCE BY RACE AND SEX

RACE	INCIDENCE	RELATIVE RISK	95% C.I.	(p)
MEN				
BLACK (n=167)	13%	----	---------	---
WHITE (n=297)	19%	1.43	(0.91-2.26)	.117
WOMEN				
BLACK (n=168)	32%	----	---------	---
WHITE (n=151)	52%	1.61	(1.23-2.10)	.000

In multivariate models, after controlling for body composition and fitness among men, race was not a significant predictor of time-loss injuries (table 5). The relative risk for white male trainees was 1.4 (p=.25). Run time was the only significant predictor of injury.

Table 5. RESULTS FROM MULTIVARIATE LOGISTIC REGRESSION ANALYSES OF TIME-LOSS INJURY REGRESSED ON RACE, BODY COMPOSITION AND PHYSICAL FITNESS CHARACTERISTICS OF MALE ARMY TRAINEES.

Variable	Coefficient	95% C.I.
Race		
1 = Black	--------	----------
2 = White	1.43	(0.76 - 2.69)
Run Time*		
1 = Very Fast	--------	----------
2 = Fast	0.43	(0.15 - 1.19)
3 = Average	1.22	(0.51 - 2.92)
4 = Slow	0.98	(0.40 - 2.39)
5 = Very Slow	1.77	(0.74 - 4.23)
Push Ups		
1 = Very Many	--------	----------
2 = Many	1.91	(0.77 - 4.75)
3 = Average	0.55	(0.58 - 3.91)
4 = Few	2.09	(0.49 - 3.40)
5 = Very Few	1.06	(0.63 - 4.23)
Strength		
1 = Very Strong	--------	----------
2 = Strong	1.17	(0.49 - 2.79)
3 = Average	1.17	(0.48 - 2.85)
4 = Weak	0.69	(0.26 - 1.80)
5 = Very Weak	1.73	(0.72 - 4.18)

*** (p) = .05**

Race was still significantly associated with time-loss injury risk in multivariate models for women (OR = 3.68, p=.000) (Table 6). Run time and sit ups were also significantly related to injury risk. The slowest women had 3.37 times the risk of a time-loss injury as the very fastest women (p = .01). Women in the lowest two quintiles of sit up performance were also at higher risk of injury (p = .01).

Table 6. RESULTS FROM MULTIVARIATE LOGISTIC REGRESSION ANALYSES OF TIME-LOSS INJURY REGRESSED ON RACE, BODY COMPOSITION AND PHYSICAL FITNESS CHARACTERISTICS OF FEMALE ARMY TRAINEES.

Variable	Coefficient	95% C.I.
Race*		
1 = Black	--------	----------
2 = White	3.68	(1.88 - 7.19)
% Body Fat		
1 = Very Lean	--------	----------
2 = Lean	0.85	(0.33 - 2.20)
3 = Average	1.27	(0.50 - 3.22)
4 = Fat	0.43	(0.16 - 1.15)
5 = Very Fat	0.77	(0.27 - 2.15)
Run Time*		
1 = Very Fast	--------	----------
2 = Fast	0.92	(0.34 - 2.50)
3 = Average	1.40	(0.53 - 3.71)
4 = Slow	3.61	(1.35 - 9.64)
5 = Very Slow	3.37	(1.20 - 9.46)
Situps*		
1 = Very Many	--------	----------
2 = Many	0.36	(0.14 - 0.97)
3 = Average	0.55	(0.21 - 1.46)
4 = Few	2.09	(0.82 - 5.32)
5 = Very Few	1.06	(0.42 - 2.73)

*** (p) < .05**

DISCUSSION

White race appears to be an injury risk factor for women and cannot be eliminated as a factor for men. Black trainees were leaner than whites. However, body fat, among female military trainees, is protective against training injuries. While percent body fat was not a significant predictor of injury it was a confounder of the injury relationship and thus important to the multivariate model. When body fat was controlled, the difference in injury risk between white and black female trainees, was even larger.

Physical fitness, particularly aerobic fitness, is also a predictor of injury. However, differences in physical fitness did not fully explain the observed association between race and risk of injury. Three possible reasons for the persistence of this association include 1) race-related physiology; 2) differences in prior physical activity; and 3) behavior. Physiology and prior physical activity relate to real differences in injury risk. Behavioral differences, such as health care seeking and risk taking behaviors, are a possible source of bias which might make the real injury risks appear different.

Physiologic differences between blacks and whites may explain some of the injury risk differential. White elderly

females are at highest risk of hip fractures, followed by white males, black females and black males[1]. A number of military studies have found black males to be at lowest risk of stress fractures, followed by white males, and black females, with white female trainees at the highest risk.[17-19] (Table 7) These patterns of risk, where white females are at highest risk and black males at lowest, seem due more to physiologic differences than to behavioral differences. It would be difficult to continue to function without obtaining medical care so health seeking behaviors are less likely to bias these injury rates. Also, they are medically identifiable which reduces the chance of patient or physician bias. These patterns are also consistent with measured physiologic differences between blacks and whites in bone mass and muscle mass. Perhaps predisposition to injury can be partially attributed to the lower bone and muscle mass observed among white women.

TABLE 7. RACE AND GENDER PATTERNS OF INJURY RISK

RACE & SEX	Hip Fractures*	Stress Fractures**	Time-Loss Injury***
MEN			
BLACK	1.00	1.00	1.00
WHITE	1.97	4.65	1.43
WOMEN			
BLACK	1.57	6.04	2.44
WHITE	3.42	51.40	3.97

* = Elderly Americans (over 85).[1]
** = Army trainees over 12 month period. [17]
*** = Time-loss injuries, from our study results

Prior physical activity probably explains some of the race differences. While black women in the civilian population tend, on average, to have a higher percent of body fat than white women, black women entering the Army have lower percents of body fat than white female recruits.[31] Black women entering the Army may be a more physically fit subset of the civilian population. Unmeasured physical fitness factors or training experience may also play a role in the injury risk differential. Previous training experience could provide trainees with skills necessary for avoiding injury as well as proper musculoskeletal conditioning for prevention of injuries.

Racial differences in the likelihood of seeking health care for a given condition a potential source of bias in this study. Studies have found that blacks are less likely than whites to seek <u>discretionary</u> health care services.[25,26] However, we found the race differences among those who sought health care to be most pronounced for time-loss injury visits which are probably <u>less</u> discretionary than injury visits overall.[32] This suggests that the differences in reported injuries are probably real and not simply the result of differences in health care seeking behavior.

Access to medical care was essentially the same for all trainees. However, provider bias, and patient-provider interactions which might influence the prescription of time off from training could not be assessed in this analyses.

Risk taking differences which may affect exposure to injury could not be completely controlled in this study. However, in this population, training was highly standardized. All trainees engage in the same type and amount of training, usually in group formations, suggesting that risk taking differences, if they exist, are subtle.

The fact that exposure to risk factors and access to health care were very similar for all trainees increases the validity of our results, but may limit their generalizeability. However, the race and gender associations with injury found in this study are consistent with other studies of military populations. Similar relationships can be expected in other military training populations. In addition, military trainees are not unlike high school track and field athletes in terms of their age, economic and ethnic diversity, the type of training they engage in and the injury rates they experience.[4,5] As such, our results may also be directly applicable to other young

athletes--particularly in situations where exposures to risk and access to care are similar.

In summary, the etiology of the observed injury risk differential cannot be adequately defined by this study alone. Further study with particular emphasis on racial differences in areas such as prior physical activity and prior physical training, socio-cultural influences on health, and risk taking behaviors, and possible provider bias may begin to clarify this issue. Future studies, comparing injuries among individuals engaging in vigorous physical activity, should adjust for possible confounding due to race.

Physical fitness, particularly aerobic fitness, is an important, and presumably modifiable, risk factor for military training injuries and probably explains some of the observed association between race and injury risk. A pre-Basic training fitness screening (e.g. a timed, one mile run) and remedial training of the lesser fit trainees may help reduce injuries among those trainees at highest risk, regardless of their gender or ethnicity.

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